Proceedings of the 2000 Winter Simulation Conference
J. A. Joines, R. R. Barton, K. Kang, and P. A. Fishwick, eds.

TAKING HLA EDUCATION TO THE WEB

Katherine L. Morse

Science Applications International Corporation
10260 Campus Point Drive, MS B-1-E
San Diego, CA 92121, U.S.A.

ABSTRACT

Now that the High Level Architecture (HLA) (DMSO 1998) is a technical reality and DoD M&S programs are moving toward compliance, there's a growing market for computer scientists and software engineers with HLA experience. There's also a long term need for continuing research in HLA-related areas. In addition, the simulation community as a whole is growing while the number of universities offering simulation courses and study programs is not. One of the key reasons is that developing new course material is a time-consuming and expensive process for professors whose time is already divided among existing teaching and research responsibilities. The Defense Modeling and Simulation Office's (DMSO) HLA University Outreach program seeks to bridge this gap with freely available course materials on the HLA. The program is currently moving to make these materials even more accessible by making them web-based.

1 INTRODUCTION

To bridge the education gap with respect to the HLA, the University Outreach Program is promulgating the HLA to colleges and universities at the undergraduate, graduate and researcher levels. The program's goals are to inform simulation users at universities of the applicability of the HLA to a broad range of simulation problems, to encourage application of the HLA to non-DoD models, to stimulate research into open HLA-related problems, and to educate students in the use of the HLA as a saleable job skill.

In conjunction with the Society for Computer Simulation's (SCS) McLeod Institute of Simulation Sciences (MISS), DMSO is developing a number of products including a graduate course curriculum module, a researcher support package, a searchable bibliography of HLA-related papers, a web-based instructional package, and web pages hosted at CSU Chico to maintain and disseminate this information.

Over the last two years DMSO and MISS have developed two course modules designed to be inserted into an existing graduate or upper division undergraduate course on simulation, distributed computing, or operations analysis. The first module covers the basics of the HLA and its use. It contains six lessons with integrated slides, course notes, and lab exercises. The second module focuses on advanced HLA topics and contains slides with detailed notes. The materials are available to download from the MISS web page at CSU Chico, <http://www.ecst.csuchico.edu/~hla>. The web page also hosts an on-line, searchable bibliography of citations and abstracts of HLA related papers, both DMSO-sponsored foundation papers and papers from university-based authors on a broad range of HLA-related topics. The number of papers already in the latter category is testimony to the considerable interest in the HLA from the university community. Wherever copyright restrictions allow, the papers are available for direct download from the bibliography.

The University Outreach Program is now looking beyond using the web as a distribution mechanism for traditional course materials to using the web as the delivery medium for individual instruction. The woeful lack of M&S courses and degree programs limits the educational opportunities for students interested in the topic. With specific respect to the HLA, the University Outreach Program is working to address this need for individual students. The program is in the process of converting its existing course materials to an interactive, web-based, instructional delivery system. We are currently investigating the applicability of several web-based instruction packages. This paper presents the current status of the conversion program and future plans.

2 HLA OVERVIEW

The High Level Architecture describes simulations in terms of federations of federates where a federation is a single, possibly networked, simulation comprised of simulator federates executing together through a Run

Time Infrastructure (RTI). The HLA is a specification, not an implementation. The specification is comprised of three documents: the Interface Specification (DMSO98), the Rules (DMSO98a), and the Object Model Template (DMSO98b). Updated versions of these specifications have just passed balloting to become IEEE standard 1516, 1516.1 and 1516.2, and are currently awaiting ratification by IEEE Revcom.

An RTI is an implementation meeting this specification. 0 shows a logical view of an HLA federation. RTI implementations may or may not have a physical architecture which matches this logical architecture.

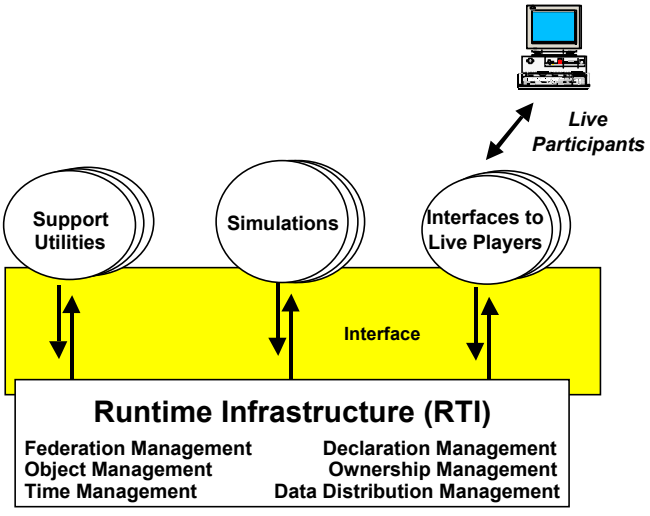


Figure 1: HLA Federation Logical Architecture

Entities simulated in a federation are called objects and are associated with federates. Objects' states are described by the values of their attributes. An object instance is an instantiation of an object class within the federate. Likewise, instance attributes are the actual attributes of object instances, while class attributes are the specifications of the attributes of an object class. The Interface Specification describes six service classes for supporting federations:

- Federation management - manages creation, control, modification and deletion of a federation execution;
- Object management - manages the creation, modification, and deletion of objects;
- Declaration management - controls the distribution of object instance attributes between federates on a class basis;
- Ownership management - manages transfer of instance attribute ownership between federates;
- Time management - controls the advancement of simulated (logical) time;
- Data distribution management - controls the distribution of object instance attributes between federates on an instance basis.

3 HLA UNIVERSITY OUTREACH PROGRAM

The HLA University Outreach Program was begun with the realization that one of the chief barriers to introduction of new topics into university courses is the time it takes for the professor to gain detailed insight into the topic, and to prepare materials for teaching the topic to the students. This is true regardless of whether the course is entirely new or the topic is just new to an existing course. DMSO invested in the University Outreach Program to lower this barrier for introduction of the HLA into university curricula. Central to the program is the goal of providing materials which a professor can first use for self-education and then use directly or with modification in a course. For this reason, the materials are all available in editable formats and professors are encouraged to share enhanced materials and class exercises. The materials are also designed to be flexible enough to be inserted into courses on related subjects such as simulation, distributed computing, or operations research, rather than as a single, monolithic course specifically on just the HLA.

3.1 HLA Course Materials

The HLA course materials available from MISS consist of two modules, basic concepts and advanced topics. The specific lessons available in each module are listed below. The lessons are of varying lengths, from 7 pages for the object model template in the first module to 48 pages on tools in the second module. Most lessons have associated references for deeper study.

Each lesson in the basic concepts module consists of presentation materials for a professor to use in class and detailed annotated class notes for distribution to the students. The class notes include copies of the presentation slides. The presentation materials are available in PowerPoint and pdf. The class notes are available in Word and pdf. The lessons may be excerpted for focused instruction germane to the class or taught as a complete module. In addition, there is a lab notebook for the first module which can be used as homework assignments. The lab notebook leads the students from downloading and installing the RTI through making modifications to a standard federate and testing it.

As advanced topics, the lessons in the second module are predicated on the students' understanding of the materials in the first module. The advanced topics are designed to focus on topics of specific interest with respect to the course being taught, or to launch individual students' deeper investigation of a topic. The materials

for the second module only consist of annotated presentation slides; there are no class notes.

A brief excerpt from lesson 2 of the basic concepts module, Introduction to a Fundamental Set of RTI Interfaces, is given in Appendix A:.

3.2 Basic Concepts

The items covered under basic concepts are:

- Introduction to the HLA
- Introduction to a Fundamental Set of RTI Interfaces
- The Object Model Template
- Basic Concepts of HLA Simulations
- Declaration and Object Management
- Management of Time in HLA Simulations.

3.3 Advanced Topics

The items covered under advanced concepts are:

- Time Management (2 lessons)
- Management Object Model
- Federation Development and Execution Process (2 lessons)
- Tools
- Data Interchange Format
- Data Distribution Management (2 lessons)
- Policy.

4 SCORM

The Advanced Distributed Learning (ADL) Shareable Courseware Object Reference Model (SCORM) (ADL 2000) is a specification developed by the DoD for exchange of course material Assignable Units (AU) among different implementations of Learning Management Systems (LMSs). The SCORM specifies both the format of the data, the AUs, and the functionality of frameworks for delivery the course material, LMSs. The specification is to ensure that any AU developed in compliance with the specification will run properly on any LMS developed in compliance with the specification. In this way, courseware can become "shareable."

An LMS is responsible for all execution functions including:

- Delivering AU content
- Tracking student progress
- Reporting on student progress
- Administering learning content
- Tracking student interactions.

The format for course content is specified in XML. Course content may consist of:

- AUs
- Raw media data such as images, sounds, text, and other presentation documents
- Assignment hierarchies that define the lesson course plan
- Objectives that state the skills, knowledge, and attitudes to be acquired by the student
- Metadata which describes the course package.

Work is underway to build repositories for sharing course content. In the near future, individual users who have LMSs will be able to go to several different repositories and execute interactive lessons of specific interest to them.

5 THE ROAD AHEAD

The next phase of the University Outreach Program focuses on providing web-based versions of the course materials developed in the first two phases. We are currently evaluating web authoring tools which produce interactive course materials and will begin development in the next one to two months. Concurrently, we will be evaluating the feasibility of converting the resulting materials to SCORM. Ultimately we would like these materials to available from many repositories with the goal of reaching the broadest possible audience.

6 CONCLUSIONS

The HLA University Outreach Program has already taken the first, obvious step toward using the web to broaden the availability of HLA education. HLA course materials, and reference materials are available on the web, and are working on a repository to which professors can submit new and enhanced course materials to share. We're now looking beyond the structure of courses to individual learning, both within and outside the university context. We're beginning to migrate course materials to the ADL SCORM standard to provide an interactive learning experience on the web with the belief that individual interest in simulation education in the near term will push long term institutional progress in simulation education. We also believe that focused industry/government investment in materials and supporting expertise can help lower the barriers to introduction of relevant simulation topics into university curricula.

We are just beginning this effort, but will have significantly more to present at the conference in December, including possibly a SCORM-compliant course material demonstration.

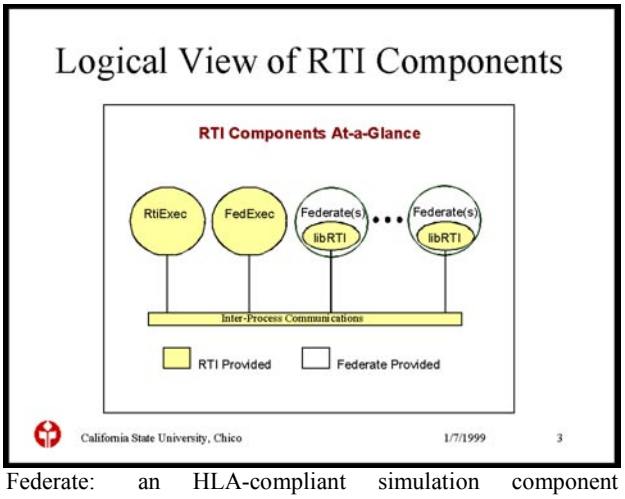
APPENDIX A: MODULE 1 EXAMPLE

HLA MODULE 1

Part 2: Introduction to a Fundamental Set of RTI Interfaces

2.1 RTI Version 1.3 Architecture: Components of an Executing HLA Federation

Figure 2 shows a high level, logical view of an executing HLA Federation. All of the components shown in the figure are part of a single federation, with the exception of the RtiExec. A brief description of each of these components is provided below.



Federate: an HLA-compliant simulation component program, plus a SOM.

Federation: Simulation composed of a set of federates interacting via the RTI services, plus a FOM.

FedExec: manages the federation. It allows federates to join and to resign from the federation, and facilitates data exchange between participating federates.

FED file: Federation Execution Data file, contains information derived from the FOM and used by the RTI at runtime.

RTIExec: a global process that manages the creation and destruction of FedExec's.

RID file: RTI Initialization Data. RTI vendor-specific information needed to run an RTI.

Figure 2: Logical View of RTI Components

A more detailed description of the FedExec, RTIExec, and the libRTI is provided in Figures 3 and 4.

Federates use the libRTI to invoke HLA services as shown in Figure 5.

Figure 3: The Federation Executive

Figure 4: The RTI Executive

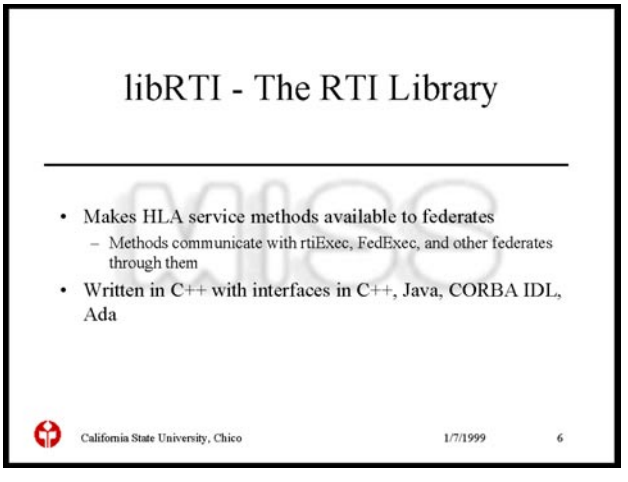


Figure 5: The RTI Library

2.2 RTI Version 1.3 Architecture: Components of a Federate

User's code for a federate is linked with *Local RTI Component Code (LRC)* from the C++ library *LibRTI* to form a complete federate. These local RTI components provide the services for the federate through communication with the RTIexec, the FedExec and other federates. (pp 2-3 of the *RTI Programmer's Guide*). The components of a single Federate are shown in Figure 2.5.

REFERENCES

Defense Modeling and Simulation Office. 1998. High Level Architecture Interface Specification, Version 1.3. Available at hla.dmso.mil.

Defense Modeling and Simulation Office. 1998. High Level Architecture Rules, Version 1.3. Available at hla.dmso.mil.

Defense Modeling and Simulation Office. 1998. High Level Architecture Object Model Template, Version 1.3. Available at hla.dmso.mil.

Advanced Distributed Learning Initiative. 2000. Shareable Courseware Object Reference Model, Version 1.0. Available at <www.adlnet.org>.

AUTHOR BIOGRAPHY

KATHERINE L. MORSE is a Senior Computer Scientist with SAIC. She received her B.S. in mathematics (1982), B.A. in Russian (1983), M.S. in computer science (1986) from the University of Arizona, and M.S. (1995) and Ph.D. (2000) in information & computer science from the University of California, Irvine. Dr. Morse has worked in industry for over 20 years in the areas of simulation, computer security, compilers, operating systems, neural networks, speech recognition, image processing, and engineering process development. Her Ph.D. dissertation is on dynamic multicast grouping for Data Distribution Management, a field in which she is widely recognized as a foremost expert. Her email is <katherine.l.morse@saic.com>.